Communication and Knowledge Management In Elegant System Design

Michael D. Watson
NASA Marshall Space Flight Center
Michael D. Griffin
Chief Executive Officer, Schafer Corporation

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Principles of Elegance

- Elegant Systems are
  - Effective
  - Efficient
  - Robust
- Elegant Systems Manage and Minimize
  - Unintended Consequences

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System Engineering Framework

- Elegant Systems are achieved through
  - Understanding the Mission Context
  - Managing the Physical and Logical System Interactions among the system components and with the system environment
    - Physics (Structural, Thermal, Fluid, Electrical)
    - Logical (Data and Information)
  - Managing the Organizational Structure and Information Flow
  - Understanding the Policy and Law Constraints
    - Federal Aviation Administration (FAA) Regulations

Properties of Elegance

- Simplicity in Function and Operations
- Espalier: Seamless integration of secondary functions
- Efficient Configuration within the Mission Context
- Robust in Operation and Application
  - Evolve in a graceful manner
- Minimize Unintended Consequences

Communication

- Communication is a critical aspect in design and operation of Elegant Systems
  - Based on organizational relationships
    - Engineering Disciplines
    - Business Units
    - Operators vs. Analysts
  - Based on physics relationships
    - Structure/GN&C
    - Airframe/Engine
  - Based on logical relationships
    - Caution & Warning/Engine Redlines

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Communication

- Communication is one of the keys characteristics of System Integration

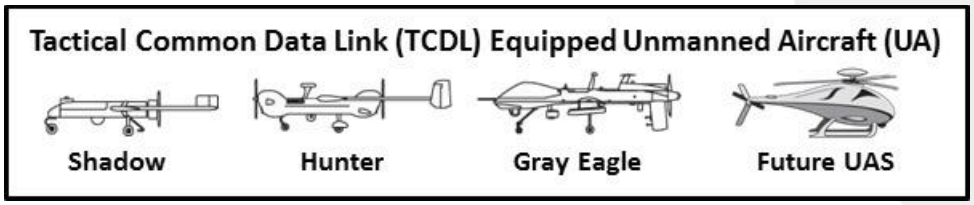
  - Communication is personal
  - Process facilitates communication, but will not maintain consistency by itself
  - Communication pathways should be simple
    - Organizational stove pipes inhibit communication and must be explicitly managed
    - Functional swim lanes help clarify responsibility and must be actively managed to avoid becoming barriers to communication
    - Optimize the number of interfaces

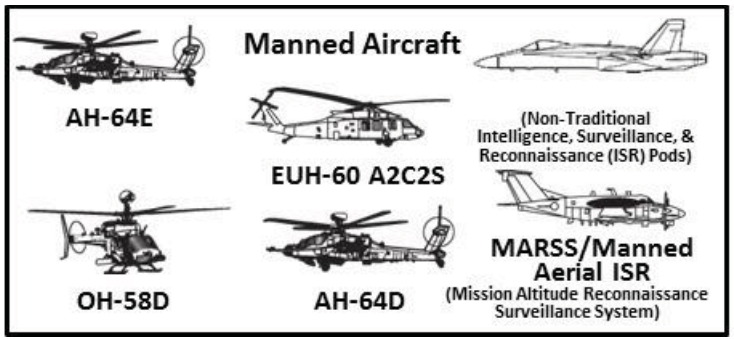
Communication

- Communication exhibits various forms of Unintended Consequences
  - Error (mistakes)
  - Ignorance (not knowing or not understanding)
  - Bias
    - Cultural Values
    - Historical Precedent
  - Short Sightedness (Imperious Immediacy of Interest)

Communication

- System Engineer:
  - Influences the Organizational Structure
  - Manages the Influence of the Organizational Structure on the System Design or Operation





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Communication

SLS SE&I MANAGEMENT STRUCTURE

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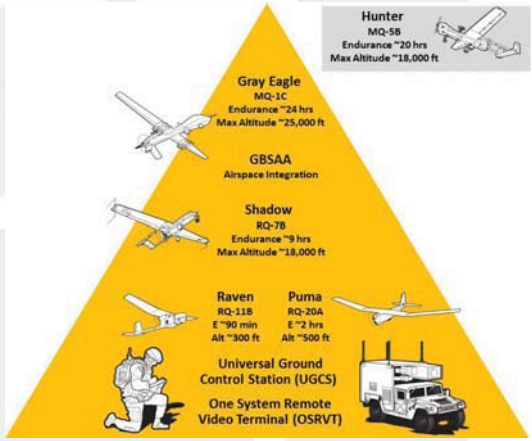
( ) = OPR [ ] = ORGANIZATIONS MAPPED TO DISCIPLINE

SLS PROGRAM OFFICE ORGANIZATION	CHIEF ENGINEERS OFFICE ORGANIZATION	Systems Engineering (EV01) [EV70, EE12]	Vehicle Management (EV40) [EV40]	Structures & Environments (StE) (EV30) [EV30, ER40, ES21, ES22]	Propulsion (ER01) [ALL ER EXCEPT ER40]	Production (EM01) [ALL EM]	Integrated Avionics and Software (ES01) [ALL ES EXCEPT ES21,ES22]	Operations (EO01) [ALL EO, ES10]	Test (ET01) [ALL ET]	S&MA (QD01) [ALL QD]
SLS Program Manager SLS Program Deputy Manager SLS Associate Program Manager Assistant PM Procurement	Program Chief Engineer Program Deputy Chief Engineer SE&I Technical Manager Assistant CE for Affordability Tech. Assist. Cross Program Integ. Tech. Assist. Ext. Interface Integ. .	LSE: EV01 Alt: EV70 Alt: EV73	DLE: EV40 Alt: EV40	DLE: EV30 Alt: EV30	DLE: ER01 Alt: ER51 Alt: ER24	DLE: EM03 Alt: EM03 Alt: EM03	DLE: ES30 Alt: ES01	DLE: EO04 Alt: EO04	DLE: ET10 Alt: ET10	Program CSO Deputy CSO QD02 SE&I S&MA Lead QD35
Stages Element Manager Stages Deputy Element Manager - Avionics Manager - Core Stage Manager - Integration Manager	Stages Chief Engineer Stages Deputy Chief Engineer Stages Deputy CE - Avionics Stages Deputy Chief Engineer - Test	EV70 Alt: EV71	EDLE: EV41	EDLE: EV34	EDLE: ER22	EDLE: EM03 Alt: EM32	EDLE: ES12	EDLE: EO40	EDLE: ET10	QD33
Booster Element Manager Booster Deputy Element Manager - Control Systems Manager - Assem & Struct Systems Manager - Motor/BSM ASM - Booster CEI/Interface Mgr	Booster Chief Engineer Booster Deputy Chief Engineer	ER50	EDLE: EV40	EDLE: ER40	EDLE: ER51	EDLE: EM03	EDLE: ES12	EDLE: EO40		QD31
Engines Element Manager Engines Deputy Element Manager	Engines Chief Engineer Engines Deputy Chief Engineer	ER20	EDLE: EV43	EDLE: ER41	EDLE: ER21	EDLE: EM03	EDLE: ES12	EDLE: ER21		QD32
Spacecraft/Payload Integration and Evolution (SPIE) Office Manager SPIE Deputy Manager	SPIE CE SPIE Deputy CE	EV70 Alt: EV70	EDLE: EV41	EDLE: EV30	EDLE: ER23	EDLE: EM03	EDLE: ES10	EDLE: EO40	EDLE: ET30	QD22
	SPIE CE SPIE Deputy CE				EDLE: ER01 Alt: ER21	EDLE: EM03				QD31

Knowledge Management

- Knowledge Management
  - Mission Context
    - Heritage Components or Designs
      - » Review of prior Program knowledge



  - Capture of Knowledge from current Design Work
    - Physical
    - Logical
    - Organizational

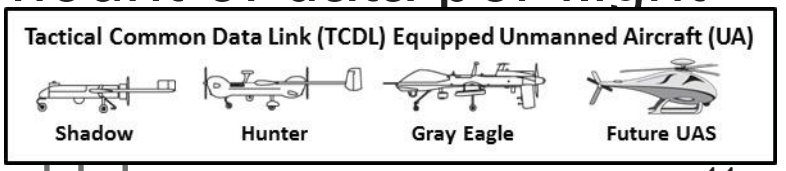
  - Data Management plays a key role in design documents, models, & drawing maintenance and accessibility

Knowledge Management

- Model based designs can add an additional challenge to knowledge capture and retention
  - Need common format to archive models

  - Requires maintenance of model tool licenses with associated version in order to view models
    - » Computer Aided Design (CAD)
    - » Computer Aided Manufacturing (CAM)
    - » Digital Manufacturing and Analysis Tools
    - » Thermal Models
    - » Computational Fluid Dynamics (CFD)
    - » Finite Element Models and Analysis
    - » Software Language Editors, Compilers
    - » System Simulation Models

- UAV/UAS have a large amount of data per flight
  - Analysis Challenging
  - Large Data volumes for archiving



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Summary

- Elegance
  - Communication and Knowledge Management are keys to System Integration
- Framework
  - Communication and Knowledge Management are characterized by the System Engineering Framework
  - Communication and Knowledge Management are keys elements of Organizational Structure and Information Flow

Acknowledgement

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